SPECIAL FEATURE

Rust never sleeps[1]: The continuing story of the Iron Bolt

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Abstract - Since 1981, Gordon Research Conferences have been held on the topic of Oxygen Radicals on a biennial basis, to highlight and discuss the latest cutting edge research in this area. Since the first meeting, one special feature of this conference has been the awarding of the so-called Iron Bolt, an award that started in jest but has gained increasing reputation over the years. Since no written documentation exists for this Iron Bolt award, this perspective serves to overview the history of this unusual award, and highlights various experiences of previous winners of this “prestigious” award and other interesting anecdotes.

1. Introduction

The field of free radical biology gained rapidly increasing interest in the 1970's and 1980's, which led to the organization of the first Gordon Research Conference on Oxygen Radicals in Biology and Medicine in 1981, which has since then continued on a biennial basis until today, and all meetings up until today have been held in Ventura, California. Form the beginning, one special feature of this meeting has been the awarding of the so-called Iron Bolt award[2], which originated as a tongue-in-cheek gesture between fellow scientists but has gained substantial prestige over the years and has accumulated a storied history. As of 2018, twenty (!) different people have received the award, and a perusal of the list of previous awardees (Table 1) will show many names of leading and pioneering scientists that have made major contributions the field. Nevertheless, the Iron Bolt award is not well known outside the GRC community, and still largely has a folklore status, and no official documentation exists for this award. We therefore wish to provide a historic overview of the Iron Bolt award, its genesis and award criteria, as well as some interesting rumors and anecdotes regarding the Iron Bolt award, in the hope of giving some more notoriety to this award. We sought the input of previous awardees with respect to their personal experiences with the award, and to hopefully dispel some existing myths and rumors that have been circulating. Unfortunately, we were not able to contact every single awardee and did not receive replies from some people (perhaps because of some embarrassment?), but many others have viewed this as a proud achievement and actually include it on their CV's.

2. The history

The story begins at the first GRC on Oxygen Radicals in Biology and Medicine, which was held in Ventura on January 12-16, 1981, and was chaired by Norman Krinsky, a former Professor of Biochemistry at Tufts University School of Medicine (Fig. 1 and Table II). According to accounts of several participants of this inaugural conference, several meeting participants, which included Lester Packer, William Pryor, Henry Forman, and some others, were walking on the beach near Ventura Pier (Fig. 2, top) during one of the afternoon breaks, and stumbled on an old rusty iron bolt that was laying in the sand near the pier. Documented history about Ventura Pier indicates that it was built originally in 1872 and is one of California's

oldest wooden piers, and that it has been burned or destroyed by storms a number of times over its lifetime, and has thus been rebuilt on several occasions. The conferees assumed that the found bolt must have fallen off the pier during one of such events and eventually washed up on the beach. Since iron is well-known to be oxidized (i.e. rust) and can contribute to free radical chemistry, it should be no surprise that the topic of iron came up repeatedly during the conference. Indeed, Steve Aust, a Professor of Chemistry and Biochemistry at Utah State University, brought up the topic of iron repeatedly during this conference. He recalls it this way: "*In the early days of the Gordon Research Conferences on Oxygen Radicals in Biology and Medicine, many chemicals were thought to autoxidize, everything from NADPH to epinephrine. I would stand up at almost every meeting and say, "no they are reductants of* ***iron*** *and the ferrous iron would autoxidize"*. Because of his persistent (and somewhat annoying!) inquiries about the role of iron and its redox state, the idea was raised by Lester Packer and Bill Pryor (and perhaps some others) that this iron bolt should be presented as an "award" to Steve, in jest and also to provide some comic relief after the intense discussions of divergent opinions during the conference. In awarding the bolt, Steve was instructed to mount the bolt on a plaque and return to the next GRC to present it to another deserving conferee, so this would become a recurring event at every meeting. Steve followed suit, and upon returning home he mounted the bolt on a piece of wood after just having cut down a walnut tree on his farm in Michigan. He fastened it with copper brackets (to also highlight the importance of copper in free radical biology) and also added brass plates with the conference and award title and his name as the 1981 awardee. And thus, the Iron Bolt Award was born!

3. How does one win the Iron Bolt?

The Iron Bolt award is clearly a bit unusual. No formal guidelines or rules exist for this award, because the award originated as a kind of joke rather than an official award, and was not intended to be based on scientific merit. There is no award committee, and instead it is the sole responsibility of the incumbent awardee to return to the next conference to select the next awardee on his/her own authority. Advice can be sought from past awardees or can be provided by attendees, but this typically is ignored. The incumbent awardee has full discretion with respect to selection criteria, which typically include: persistence in defending a position,

provocative ideas, or otherwise brilliant, insightful, or inappropriate remarks (as a play on words, the award has sometimes also been referred to as **Iron Bold**), and other criteria listed in Table III. Victor Darley-Usmar, who won the award in 2006, favors the idea that the award should be given for someone's *"slavish devotion to an idea that is clearly wrong!"* In any case, the only agreed upon rules were that the award should not be given to scientists who actively and deliberately solicit for the award during the meeting, and cannot be given to previous awardees. Originally, the award was presented during the closing banquet in a special "ceremony", but at more recent meetings the tradition has been to have a "formal" presentation by the current holder after the final session of the conference, allowing him/her to present a slideshow with some historical perspective. Another interesting feature of the award is that, since the award decision can be postponed until the last minute, and the prospective awardee needs to be present at the time of award, his or her name is actually not on the plaque. Each awardee is expected to add his/her own name to the plaque, and is also allowed to add other changes to the award as long as none of the original features are removed (although the latter is not a formal rule either).

4. Experiences with the Iron Bolt

Given this interesting background, it should be no surprise that many interesting stories exist about the Iron Bolt. One of the most common stories are related to concerns about getting the bolt through airport security, especially when carried as hand luggage, and many past winners recounted curious looks from security offers during their travels and questions about the purpose of this iron bolt mounted on a piece of wood. The origin of the bolt has also been questioned, and some previous awardees have even consulted archeologists in the hope of learning it might have come from a shipwreck. Alas, the real story is less interesting: it clearly came from the Ventura Pier, and many similar bolts can still be seen within the pier today. Another circulating rumor has been that the current bolt on the plaque is actually not the original one found at the first meeting, because one of the early awardees was not able to get the bolt across airport security and a replacement bolt had to be obtained. Wim Koppenol, who was in fact the second awardee in 1983, has claimed responsibility for this rumor and sets the record straight: *"That is a myth. The bolt is the original bolt. The origin of this story may be the following. In 1983, after getting the bolt, my flight from LA was delayed for 48 hours due to a*

snowstorm in Baltimore. However, I went through security two times carrying the mounted bolt in a strong paper bag as hand luggage, to be told that the flight was delayed. Then there was the third time, when we finally left. I did get strange looks from the security people every time, especially when I explained that it was an award. However, the bolt was not confiscated. I told the story, a bit exaggerated, when I passed on the bolt". Many colleagues recall that Wim had the habit of repeatedly getting up during or after lectures, stating that certain proposed redox-based reactions are thermodynamically impossible, in his characteristic commanding style, which was the primary the reason why he won the Bolt at the 1983 meeting. In 1985, Wim passed on the award to Edmund Copeland, who at the time was working at NIH and was instrumental for helping fund the conference. Since no clearly deserving statements were uttered at the conference, Wim chose to award Ed for his essential contributions to this GRC. The award was given to John Eaton at the next conference, and although it is not clear why, those who know John know that he could be quite a prankster! During this time, John struck up a friendship with Simon Wolff, who was awarded the Bolt at the next meeting in 1989. Unfortunately, Simon passed away unexpectedly in 1995, and an obituary published in the journal Free Radical Research (in Vol. 24, 1996), written by John and Nick Hunt recounts an interesting exchange regarding John Eaton's hypothesis that the lens is protected from oxidative free radical chemistry because – in his words – *"the lens is canned"*. In response, Simon was noted as saying that *"that is the stupidest thing I've ever heard"*, clearly an award-worthy statement!

In 2000, the award was given to Tony Kettle, from the Center of Free Radical Research at the University of Otago in New Zealand, for demonstrating the extreme oxidizing potential of hypochlorous acid. He claimed that hypochlorous acid is so powerful that it can actually dissolve bacon – and without the need for iron! - and supported his thesis by conducting an actual experiment during his presentation, which required him to leave the room to get some bacon and household bleach from the hotel kitchen. Every member in the audience, bar one, was instantaneously convinced by this real-time experiment! The lone dissenter, the inimitable Skip Smith, argued in his typical style that the bacon dissolved because of saponification, not the oxidizing capacity of bleach. Tony retorted that you should never let science get in the way of a good story! During the closing banquet at the next GRC in 2002, Tony in fact repeated this experiment, with similar results and again to hilarious effect! He then presented the award to Joe Beckman, at the Linus Pauling Institute in Corvallis, OR, for pointing out the importance of

peroxynitrite for inducing hydroxyl radical-like chemistry independent of iron and stating that *"the role of iron in free radical biology should be a tiny screw rather than an iron bolt"*.

5. Rules are made to be broken

The reasons for awarding the Bolt were not always related to controversial scientific statements. In fact, Valerie O'Donnell was given the award in 2004 because she deliberately made Joe Beckman walk back and forth with the microphone during the question portion in a session that they co-chaired, making Joe *"feel old"*. In turn, Valerie choose to bend the rules again at the next meeting, by giving it to Victor Darley-Usmar for canvassing, even though it was against the initially stated rules. Victor then presented the bolt at the next meeting to Jon Lundberg, simply for being amused by his experiments involving chewing spinach and spitting in tubes to proof the importance of oral nitrate reductase activity. In 2012, Jack Lancaster also broke with an initial rule, by awarding the bolt to Wim Koppenol for a second time! At the next conference, Wim gave the award to Neil Hogg, for stating that Wim - despite being a double boltee[3]! - had still misunderstood part of his lecture. Wim of course claimed that this is *thermodynamically impossible*! Two years later, Neil passed on the award to Tobias Dick, for answering a question about the possible role of nitric oxide in his research by stating that they *"simply ignore NO in their research, otherwise things would become too complicated"*. For deliberately ignoring NO, Neil concluded that Tobias fully deserved the bolt. So, it is clear from these stories, and from other considerations listed in Tables IV and V, that there really are no clear criteria or rules! However, it also apparent that the award is typically given to people with strong credentials in the field, and therefore is really viewed by many as a badge of honor! In fact, when Wim Koppenol retired from ETH in 2014, the president organized a retirement dinner for all faculty that were leaving that semester, and recalled everyone's career accomplishments including the fact that Wim was awarded the Iron Bolt in 1983, realizing soon thereafter that he actually got it twice.

6. It's not all about iron!

Over the years, the wooden plaque with the Iron Bolt has undergone several modifications, in addition to the continued addition of brass name plates of new awardees over the years, which are gradually filling up the plaque (see Fig. 2). Gideon Czapski, a physical chemist from Hebrew University of Jerusalem, was offered the award in 1990 and decided to decorate the iron bolt by wrapping it in copper foil, to emphasize the importance of copper in addition to iron. The increasing focus on nitric oxide in free radical biology in subsequent years was commemorated by the attachment of a vial containing yellow salt (reflecting peroxynitrite) to the plaque (see Fig. 2). Because of his seminal work on peroxynitrite, Joe Beckman was often suspected to have done this, but a picture of the plaque shared by Victor Darley-Usmar in 2008 (i.e. well after Joe was in possession of the bolt between 2002 and 2004) still show this vial missing from the plaque. The culprit must have been a more recent winner, and after inquiring with subsequent awardees, we finally learned that Wim Koppenol – him again! – had obtained some irradiated cesium nitrate salt (from his colleague Scott Bohle) and decided to put it in a vial on the plaque after he won the bolt again in 2012. As Wim stated, irradiation of this salt converts a tiny fraction of it to peroxynitrite (thus giving it the yellow color), which *"is almost eternally stable as long as you keep it away from sunlight"*. Such an explanation is not very useful in avoid airport security concerns, and this issue is therefore best avoided this issue. In fact, some have explained that the vial simply contains fine sand. According to some, sticking the bolt in your checked luggage seems a safe option as well.

This brings us to today, and the 2018 meeting was just held in February, during which Tobias chose to again break with tradition. Perhaps troubled by the lack of clearly deserving statements during this last meeting (at least during the sessions!), he chose to award the bolt to 2 people instead of one, reasoning that *"this GRC has 2 chairs and 2 vice chairs, so why not 2 iron boltees?"* The logistical problem of having 2 people share one award was avoided by awarding 2 scientists at the same institution, preferably with offices adjacent to each other! Tobias probably didn't realize that this still left a number of eligible candidates present at the conference, and there was still some notable anticipation throughout the in the room when the final "winners" were announced. In any case, award was handed to Yvonne Janssen-Heininger and Albert van der Vliet, both at the University of Vermont, even though neither of them recall having said anything notably controversial or witty. Perhaps they received this "honor" because, like Tobias, they also tend to ignore NO in their recent research efforts, or because they both asked a

substantial number of questions throughout the conference, clearly outcompeting most other potential contestants. Tobias' lips are sealed, so we may never know!

7. Towards the future

We hope that this article will give the reader a good perspective regarding the significance and history of this increasingly prestigious Iron Bolt award, and clears up some of the circulating myths around this award. Some mysteries nonetheless remain, as some attempts to seek input from fellow boltees were met with evasive remarks. As stated earlier, one reason for this historic perspective is to enhance visibility of this award. In fact, Tobias has actually attempted to create a Wikipedia page about the Iron Bolt, only to find his stub being rejected for apparent lack of general novelty or interest. In awarding us, he charged us with following up on this effort, and this perspective should hopefully help achieve this. Clearly, our research field is filled with colorful personalities and strong opinions, and a simple perusal of the awardees names and dates in Table 1 also gives a good sense of how the research field itself has evolved over the years. We therefore fully expect the Iron Bolt to be a coveted award in the future, for as long as the Oxygen Radicals GRC will continue to be held. Space is quickly running out on the plaque for addition of future awardee names, so it will take some creative mind(s) to come up with solutions for this problem over the next years. It will certainly be interesting to witness the further evolution of the Iron Bolt in future years.

Footnotes:

1: This phrase originated as the title of a live album by Canadian singer-songwriter Neil Young, and supposedly elutes to his desire to avoid complacency and continue innovating. It certainly also applies to the research field of biological oxidation, which continues to evolve.

2: Coveted award given bi-annually at the Gordon Conference for Oxygen Radicals to one or more attendees of the conference for either notable comments, behavior, or other circumstances.

3: Insider name for former or current Iron Bolt Award winners

Year	Awardee	Affiliation	Country
1981	Steve D. Aust	Utah State University, Logan	USA
1983	Willem H. Koppenol	University of Maryland, Baltimore	USA
1985	Ed Copeland	NIH	USA
1987	John W. Eaton	University of Louisville, Kentucky	USA
1989	Simon Wolff (†1995)	University College London	United Kingdom
1990	Gidi Czapski	Hebrew University of Jerusalem	Israel
1992	Catherine Rice-Evans	King's College Oxford	United Kingdom
1994	Balaraman Kalyanaraman	Medical College of Wisconsin, Milwaukee	USA
1996	Fulvio Ursini	University of Padova	Italy
1998	Matthias W. Hentze	European Molecular Biology Laboratory (EMBL), Heidelberg	Germany
2000	Anthony J. Kettle	University of Otago, Christchurch	New Zealand
2002	Joseph S. Beckman	Oregon State University, Corvallis	USA
2004	Valerie O'Donnell	Cardiff University	United Kingdom
2006	Victor Darley-Usmar	University of Alabama at Birmingham	USA
2008	Jon Lundberg	Karolinska Institutet, Stockholm	Sweden
2010	Jack R. Lancaster	University of Alabama at Birmingham	USA
2012	Willem H. Koppenol	Eidgenössische Technische Hochschule (ETH), Zürich	Switzerland
2014	Neil Hogg	Medical College of Wisconsin, Milwaukee	USA
2016	Tobias P. Dick	German Cancer Research Center (DKFZ), Heidelberg	Germany
2018	Yvonne Janssen-Heininger & Albert van der Vliet	University of Vermont	USA

Table I: List of previous Iron Bolt awardees to date.

Table II: List of attendees at first Gordon Research Conference on Oxygen Radicals in Biology and Medicine

1. C. Channa Reddy
2. Henry Jay Forman
3. ?
4. J. Edwin Seegmiller
5. Pariman S. Rao
6. James Raleigh
7. L.K. Patterson
8. Lester Packer
9. Norman I. Krinsky
10. William A. Pryor
11. Raj Sridhar
12. Harold Schwartz
13. Gerald Rosen
14. Chr. Ferradini
15. Balaraman Kalyanaraman
16. Arnold Stern
17. Arthur Cederbaum
18. Bruce Freeman
19. Charles N. Serhan
20. David Stone
21. Donald C. Borg
22. Kenneth Wong
23. Estuo Niki
24. Roy Schenk
25. Larry Machlin
26. Joe McCord
27. James Hutchison
28. Tony McDonagh
29. Chirs Foote
30. Cameron Koch
31. Keith Ingold
32. Kelvin J.A. Davies
33. W. Lohman
34. Robert A. Floyd
35. Trevor Slater
36. Robin Wilsson
37. Garry R. Buettner
38. Alfred I. Tauber
39. Stephen J. Weiss
40. K.J. Kunert
41. Barry Halliwell
42. Gerhard Sandman
43. D.B. Brettler
44. Bruce N. Ames
45. W.H. Baricos
46. S.V. Shah
47. David Lightner
48. Rolf Mehlhorn
49. Johan E. Van Lier
50. ?
51. Brian G. D'Aoust
52. Robert A. Stein
53. J. Pucheault
54. Peck-Sun Lin
55. Stefan Marklund
56. Gideon Czapski
57. C.F. Moldow
58. Elaine Berger
59. Garry J. Handelman
60. Robert I. Lin
61. James F. Mead
62. C. Norman Gillis
63. Robert L. Baehner
64. Larry Marnett
65. Michael A. Marletta
66. Bernard Goldstein
67. C.C. Cloud
68. Hartmut R. Schroeder
69. John Butler
70. Richard H. Simon
71. Robert I. Lehrer
72. Robert W. Egan
73. Dorothy Delahunty
74. Anne Autor
75. Patricia Andrews
76. Susan Deneke
77. Carl F. Deneke
78. Bertram Lubin
79. John E. Repine
80. Robert E. Lynch
81. Rolandro Del Maestro
82. John R. Totter
83. Garth Powis
84. Edmund S. Copeland
85. Steven Aust
86. Leland L. Smith
87. James E. Smolen
88. James R. White
89. Harry W. Dougherty
90. Robert E. Anderson
91. Zvi Friedman
92. John Eaton
93. Bengt Gerdin
94. E.L. Powers
95. R.S. Sohal
96. J. Terrell Hoffeld
97. Michael A. Trush
98. Alberto Boveris
99. Benjamin H. Landing
100. Edmund Lengfelder

Other conferees not included in the picture include Paul Hochstein and Alex Sevanian

Table III: How to qualify for the Iron Bolt Award

- Absolutely brilliant and insightful question, comment or remark.
- Amazingly inane or inappropriate remark.
- Devotion to an idea that is clearly disproved by your own data.
- Persistent questions that are more about you than the science.
- Insulting the current bolt holder.
- Opening your mouth.

Table IV: Some winning actions or comments

● Conducting a definitive experiment in front of all GRC participants to show the impact of bleach on bacon

● Spitting in a tube with or without spinach

● Addressing a question about the relevance of NO, by stating that NO is simply ignored

● Compassion for colleague who had tried hard for many years to win the bolt, unsuccessfully

● Robust confirmation in front of the entire GRC audience that someone had clearly misunderstood the lecture (i.e. missed the point entirely)

● Having next door offices (this is likely a fake argument).

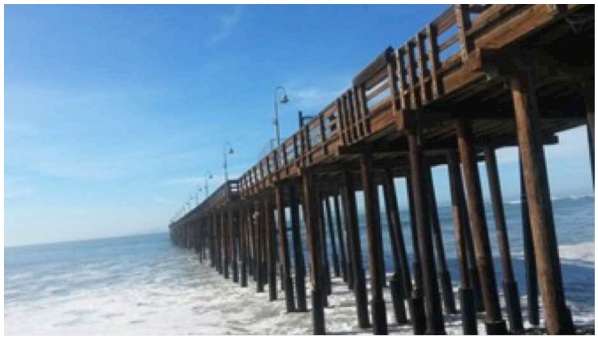
● Stating that: “That reaction is thermodynamically impossible” after every lecture

Table V: Documented “close-call” qualifying comments or actions

- “O_2 is an oxidant”
- “Is a lot of good bad for you?”
- “I see a nitrative future…….”
- “I know the alphabet from A to T”
- “One can collect drool from people by simply hanging them upside down”
- Answering a question by stating: “I love the mysteries of life”
- Demonstrating the impact of immune modulation in Canadian snowmen with or without shovel.
- Telling an attendee to take a time-out because you did not like the tone of their question.
- In a 25 minute lecture, showing 60+ slides multiple times.
- “My post-docs eat as much lab-chow as they like. I even tried it myself”
- Comment: “I think that this is a teleological argument” Response: “I do not know anything about theology!”

Figures:

Figure 1: The attendees of the first Gordon Research Conference on Oxygen Radicals in Biology and Medicine in 1981, which was held in the Holiday Inn on the Beach in Ventura, California. Numbers refer to listed names in Table II. Picture provided by Henry Forman.



The Ventura pier

The Bolt in 2008

The Bolt in 2018

Figure 2: Top: The Ventura Pier from which the Iron Bolt is thought to originate (picture courtesy of Tobias Dick). Middle: the Iron Bolt Award in 2008 (picture courtesy of Victor Darley-Usmar). Bottom: the Bolt in 2018 (photo by Veronica Darragh). Note the various modifications between 2008 and 2018.